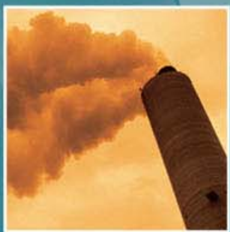
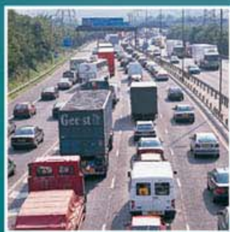
Thanet District Council

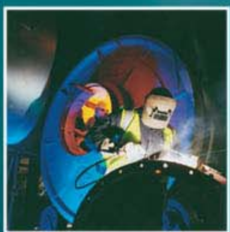
Thanet District Strategic Flood Risk Assessment

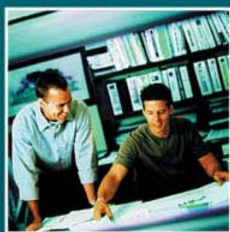
Volume 3 – Modelling Methodology

24 April 2009









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Contents

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1. Introduction to SFRA TuFLOW Modelling

The SFRA required detailed hydraulic modelling to be undertaken in Margate and Birchington. The fully 2-Dimensional hydrodynamic model TuFLOW was used to produce the required flood extents. The modelling methodology for the production of Flood Zone extents is inline with Environment Agency guidance. This modelling Appendix is separated into the following sections:

1. Model input data;
2. Model schematisation and simulations;
3. Model parameters;
4. Discussion of modelled results.

1.1 Model Input Data

The key model input data, their sources and their uses are presented in the table below.

Table 1.1 Model Input Data for TuFLOW Breach Modelling

Input Data	Source	Use in the Model
Tidal Hydrograph*	Channel Coastal Observatory National Oceanography Centre, Environment Agency “Extreme Sea Levels – Kent, Sussex, Hampshire and Isle of Wight” Summary Report 2004, PPS25, Proudman Oceanographic Laboratory (POL) Tidal Marine Statistics for Margate	Tidal overtopping modelling utilises a stage hydrograph as the input, (not a flow (Q) as in a fluvial system) which prescribes the tide levels throughout the model simulation
Digital Terrain Data (4m)	Environment Agency – Digital Mapping Team in Twerton	The digital terrain model (DTM) is the foundation of the model and defines the land elevation. It is therefore critical in determining the extent of flooding.
Defence survey heights	Thanet District Council	The defence crests heights are critical controls which determine the level at which water will first inundate the floodplain.
Building Outlines	OS Landline Mapping	Building outlines can be represented in three ways; the preferred method for this type of investigation has been adopted whereby buildings are modelled as areas of very high surface roughness. This allows water to flow very slowly through them, and provides a nominal amount of storage volume..

1.1.1 The Digital Terrain Model

The data was supplied by the Environment Agency's Digital Mapping Team in Twerton. The source data was issued at a 2m resolution. For the purposes of the SFRA, this data was resized in ArcMap to a 4m resolution. This process was undertaken to reduce computational times. A 4m resolution is considered to be appropriate for SFRA mapping purposes. The TuFLOW .zpts were derived from the 4m resolution grid.

1.1.2 The Tidal Hydrograph

The methodology used in this SFRA to generate the tidal hydrographs at Margate and Birchington,as provided below, was documented and circulated for comment in April 2008. It has been assumed that the tidal hydrographs at Margate and Birchington are identical as there was no data available to verify any differences and it was thought that they would be marginal, if present.

The following data and consultation was utilised in the production of the hydrographs:

- Proudman Oceanographic Laboratory (POL); tidal marine statistics for Margate;
- Channel Coastal Observatory; tide records (2003 to 2007) for Herne Bay;
- The Environment Agency "Extreme Sea Levels – Kent, Sussex, Hampshire and Isle of Wight" Summary Report 2004;
- PPS25; for climate change induced sea level rise rates;
- Flood Risk Mapping team of the Environment Agency;
- Environment Agency Thames Barrier modelling team.

1.1.3 Methodology

In deriving design tidal hydrographs, there are five key components to be considered:

- Normal tide the 'baseline' astronomical tide consider to occur in average conditions;
- Storm surge: the local change in water level along a shore due to a storm;
- Wind/wave setup: the increase in water level within the surf zone above mean still water level caused by the breaking action of waves, or by the "piling up" of water on the coastline by wind;
- Wave run-up: an oscillatory phenomenon referring to the vertical distance the uprush of water from a breaking wave reaches;
- Other factors (climate change, meteorological oscillations).

Due to the geographical characteristics of Margate and Birchington, it was considered that the tidal hydrograph is comprised only of the normal tide, storm surge and climate change.

1.1.4 Derivation of the Extreme Tide Levels

The peak level for the baseline (2000) 1 in 200 and 1 in 1000 year tides were for Margate from Table 4 in the "Extreme Sea Levels – Kent, Sussex, Hampshire and Isle of Wight" Summary Report 2004. These levels, already include an allowance for storm surge, but not wave run-up or setup. The 1 in 200 year and 1 in 1000 year levels were reported as 4.4m AOD and 4.8m AOD respectively. The peak levels for climate change scenarios were derived by adding the incremental sea-level rise estimates provided in PPS25,.for the years 2010 and 2115. The resultant values are presented in the Table 1.2.

Table 1.2 Peak Sea Levels at Margate Calculated for SFRA

Year	1 in 200 Level mAOD	1 in 1000 Level mAOD
2000	4.4	4.8
2010	4.44	4.84
2115	5.56	5.96

Initial trough levels for the events were based on tidal statistics for Margate, obtained from POL (Proudman Oceanographic Laboratory). These included both the mean low water spring and neap tides. As the determination of the design tide events are partially based on a statistically generated high astronomical tide, which are associated with low ebb tides, the mean low water spring level was adopted as the initial trough level. This level however, does not include a storm surge component and needed to be modified, discussed further in the following section.

1.1.5 Derivation of the Extreme Tide Hydrograhps

The above levels determine the peak extreme tide level, however the shape of a tidal hydrograph is equally important as it dictates the volume and timing of water flow.

The determination of the period and shape of the tidal cycle was based on tidal records from the Herne Bay gauge. Records were obtained for the 2003 to 2007 period from the Coastal Channel Observatory. This data set included a continuous predicted tide levels and a continuous record of the observed tide levels. The difference between the two (the residuals) were also available for analysis. The design tide hydrograph was therefore based on the shape of the predicted tidal records, manipulated to encapsulate the previously determined peak and trough levels.

The tidal records for Herne Bay gauge were then also used to incorporate a storm-surge element to the shape of the hydrograph. A review of the data and consultation with archived new events revealed that the storm in November

2007 (7^{th} to 11^{th}) was the largest recorded at the Herne Bay gauge. Analysis of the residuals (considered to be the storm surge component) showed that the maximum surge event occurred in between astronomical tidal peaks.

For the purposes of this investigation, it was considered appropriate that the peak storm surge would coincide with peak of the normal tide. The storm surge component was then added to the normal tide, by applying the residuals to the baseline tidal hydrograph. However, as the peak levels were already known, the hydrographs needed to be scaled as to fit these levels. For example, the peak 1 in 200 year tide level (year 2000) was shown to be 87% of the peak design tide hydrograph, and therefore the hydrograph was scaled by this factor.

This method of scaling the surge and adding it to the spring tides produced a tidal hydrograph with the most realistic shape that was possible to be produced using the available data. The results are presented in figures 1.1 and 1.2.

Figure 1.1 Tidal hydrograph for Margate Sea Levels (200 year levels) and Residuals

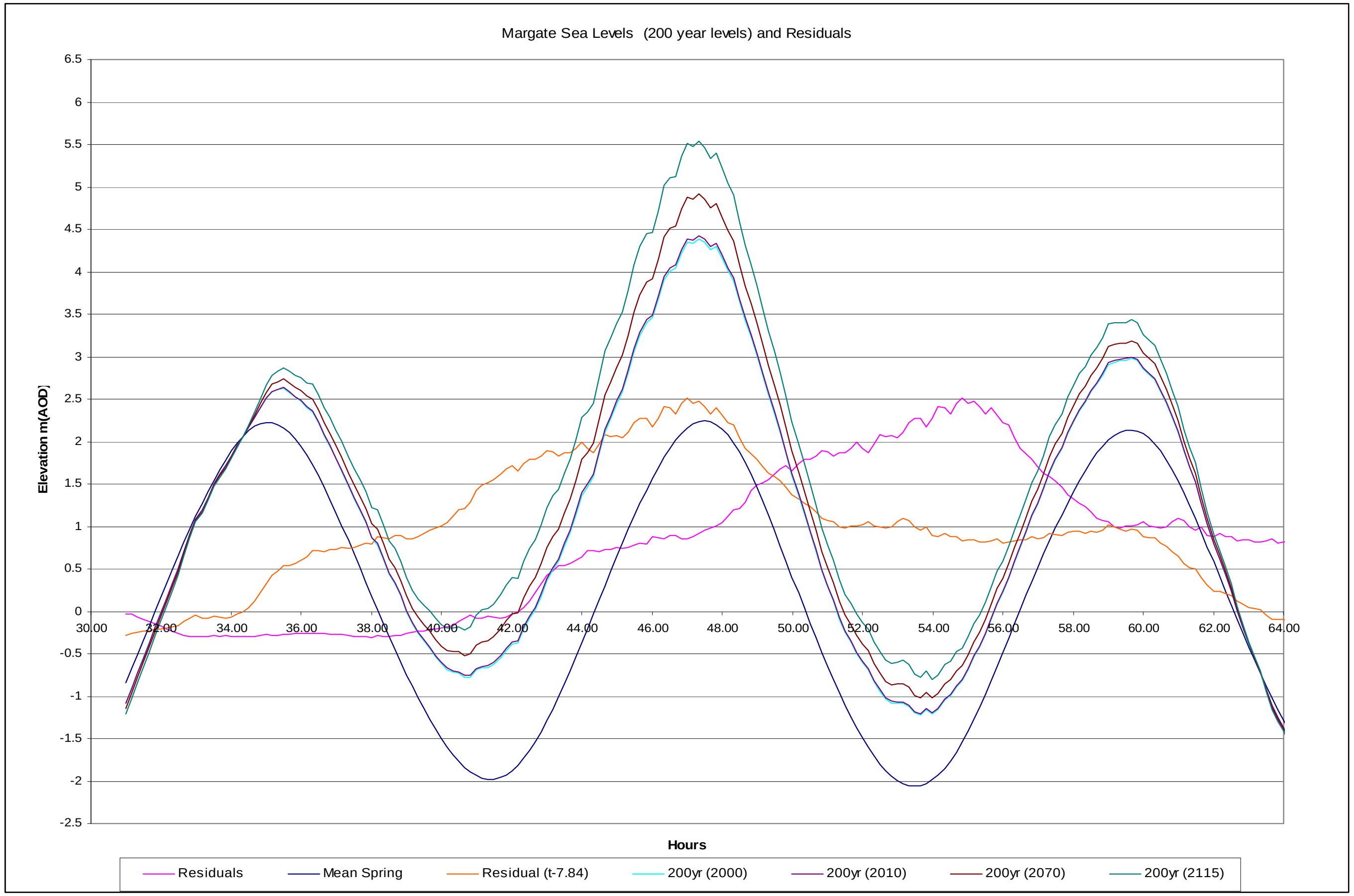
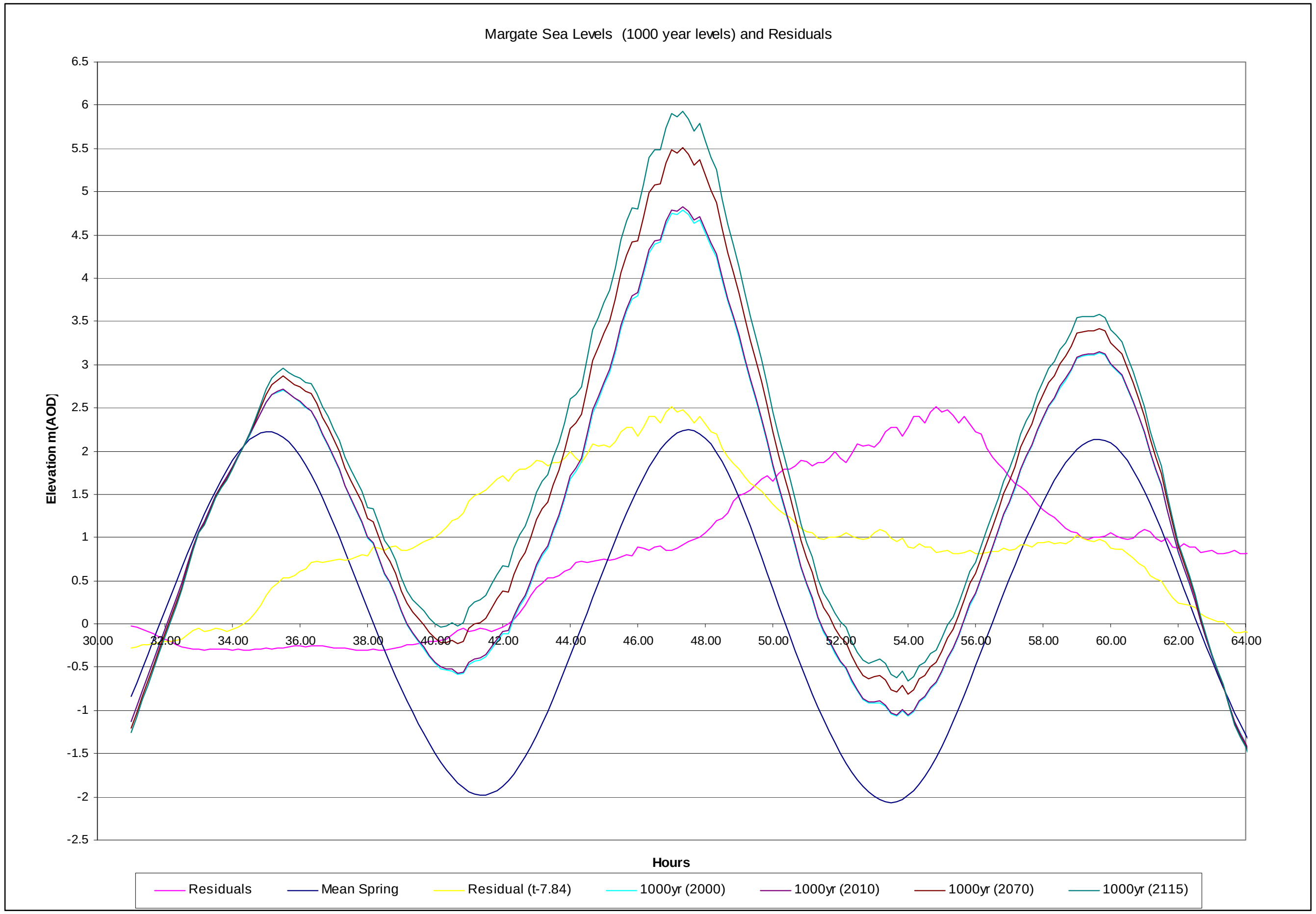


Figure 1.2 Tidal hydrograph for Margate Sea Levels (1000 year levels) and Residuals



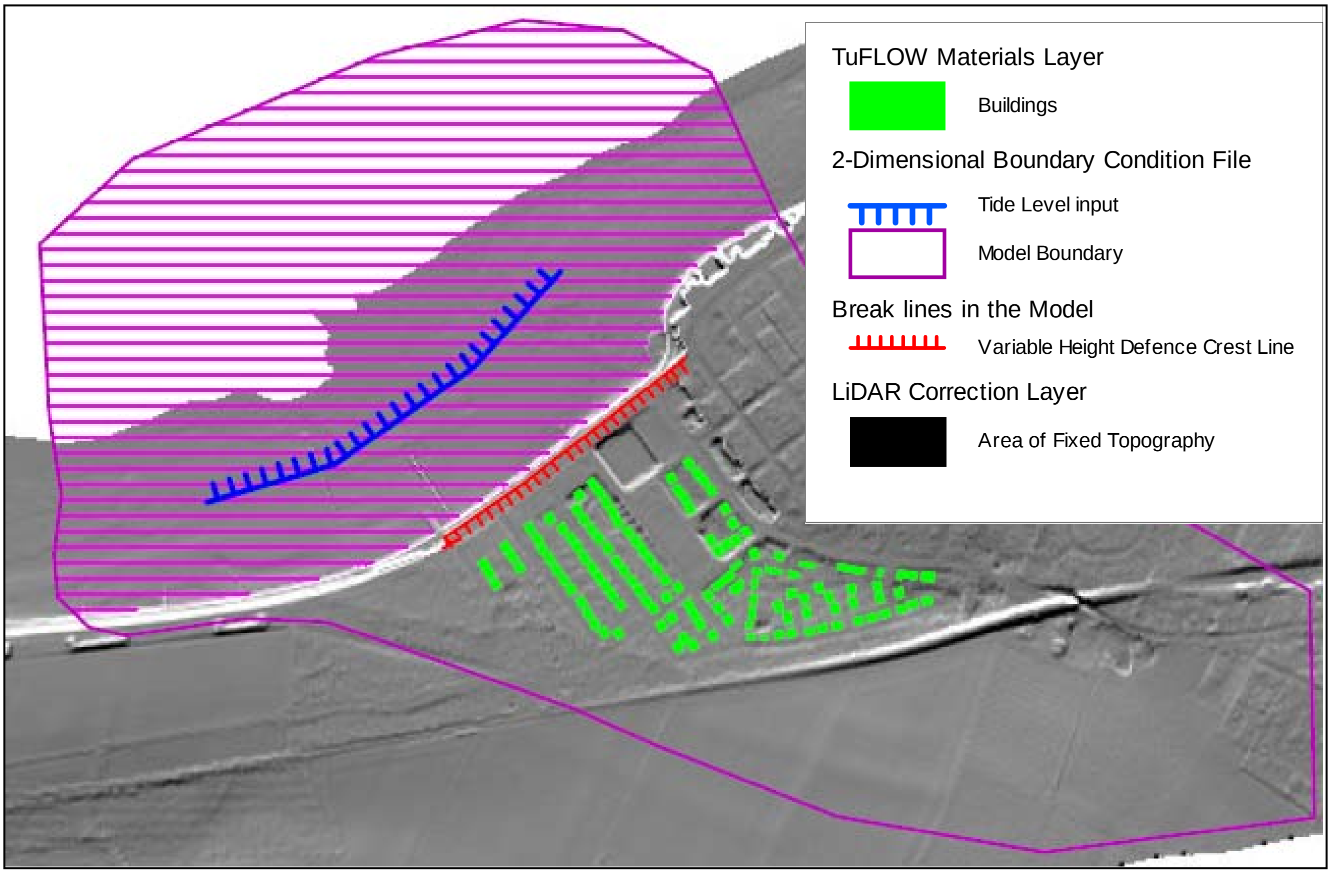
2. Model Schematisation and Simulation

2.1 Model Schematisation

This process refers to how the two models were configured. The Margate and Birchington models were constructed independently of each other, with the Margate model being considerably larger and more complex. In this Margate there are two areas of tidal floodplain to be represented as well as a 1-dimensional pipe network element to the model in the Dreamland site. This complexity was not present in the Birchington area. Figures 2.1 and 2.2 illustrate the composition of the Margate and Birchington models respectively.

Figure 2.1 Model Schematisation in Margate

Figure 2.2 Model Schematisation in Birchington



2.2 Model Simulations

Eight simulations were run for each model, as detailed in Table 4.1 (page 16) in the main report.

2.2.1 Defended Scenarios

In the defended scenarios, the seawall structure was incorporated in to the model (including additions to the seawall post 1953). The defences in Margate and Birchington were surveyed by Thanet District Council in summer 2008, copies of which are presented at the end of this Appendix. This survey captured the crest height of the defences and the height of the walkway on the landward side of the sea wall. During the defended scenarios, it was assumed that the wooden blocks at the base of the *Formal Defences* were in place. The wooden blocks are used by the Council to plug drainage holes which are at foot path level in the defence wall. These holes are designed to allow spray to drain back into the sea.

2.2.2 Undefended Scenarios

The Environment Agency only considers the post 1953 additions as *Formal Flood Defences*. During the undefended scenarios, only this top tier of the sea wall structure was removed from the model. The defence crest line remains the same in both models.

2.3 Model Parameters

Other than the tidal hydrograph, seawall defences and the DTM, there were relatively few parameters in the model. The DTM was established using filtered LiDAR at 4m resolution. The table below outlines the roughness values that were used in the models.

Table 2.1 Model Roughness Values

Model Component	Manning's n Value
Buildings	0.5
All other surfaces	0.035

The pipe network in the Dreamland area of Margate was incorporated into the model to represent the potential risk associated with failure of the outlet flap (that is, being removed or jammed open). The network was based on the information supplied by the Environment Agency copies of these data are presented at the rear of this Appendix. Unfortunately the drainage network survey was not complete and the elevations of the pipe inverts appeared erroneous. Rather than make assumptions to complete the network, a simplification of the network was modelled. This involved making a *flat* network with no gradient (set to the beach invert level), with all pipes modelled at the same diameter. This configuration was assumed to replicate the worst case scenario and as such the lowest energy loss coefficients recommended by the TuFLOW user manual (2007) were used. The pipe parameters are presented in Table 2.2 below.

Table 2.2 Model Roughness Values

Parameter	Vaule
Culvert Height contraction Coefficient	0.6
Culvert Width contraction Coefficient	0.9
Culvert Entry Loss	0.1
Culvert Exit Loss	0.1

2.4 Model Results

Section 4.2 in the main report (volume 1) describes the results of the various model simulations. The following figures depict the results of the 8 model simulations for the undefended scenarios only that have been run for the Thanet SFRA.

Margate

Figure 1 - 1 in 1000 year (2115) Undefended

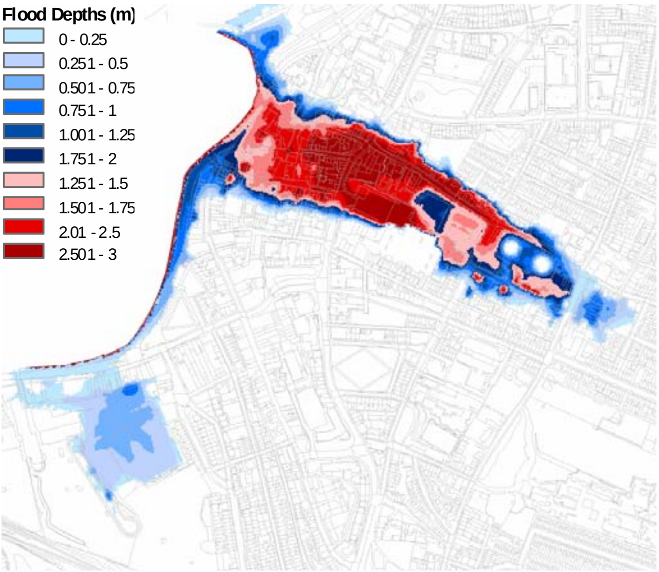


Figure 2 - 1 in 1000 year (2010) Undefended

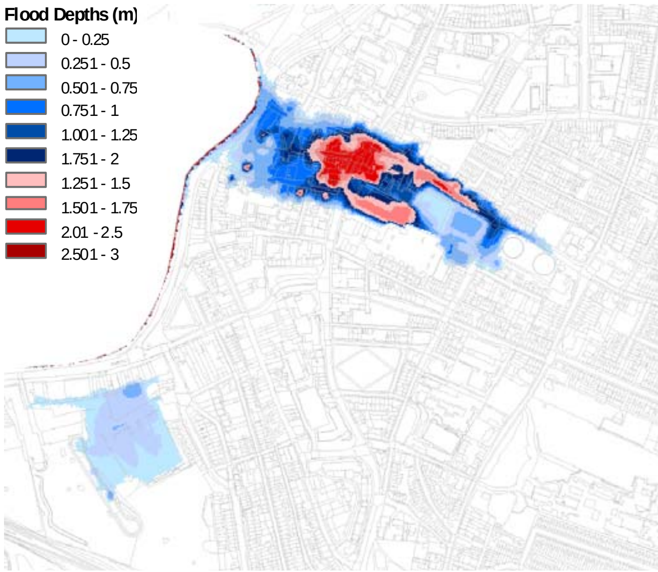


Figure 3 - 1 in 200 year (2115) Undefended

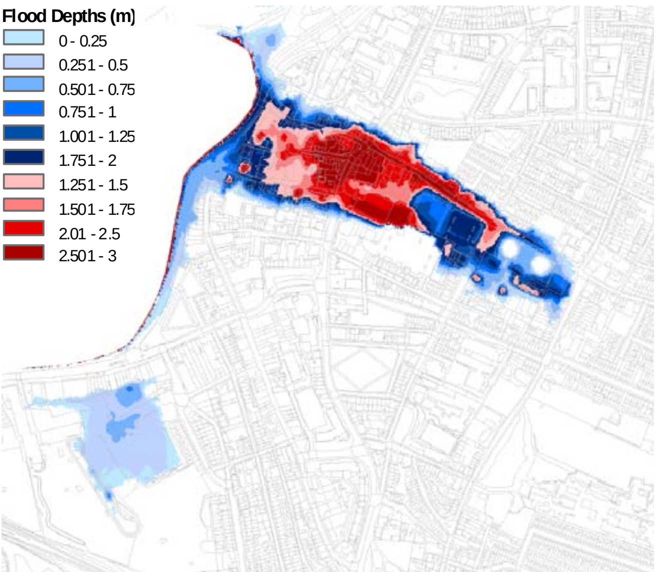
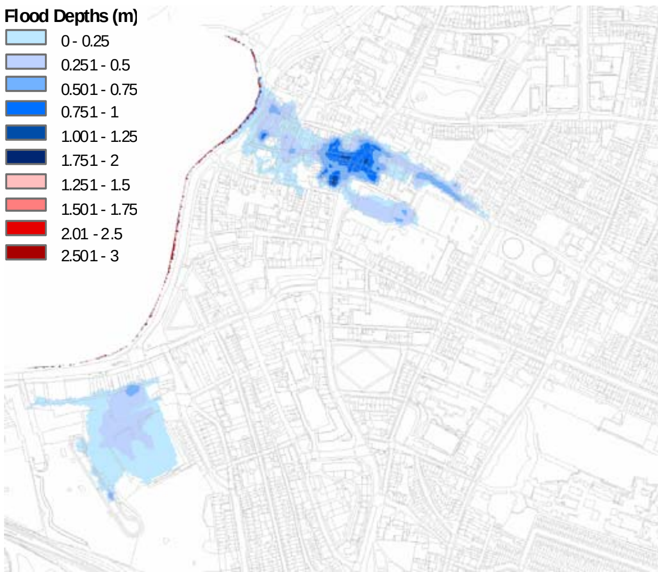


Figure 4 - 1 in 200 year (2010) Undefended



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Birchington

Figure 5 – 1 in 1000 year (2115) Undefended

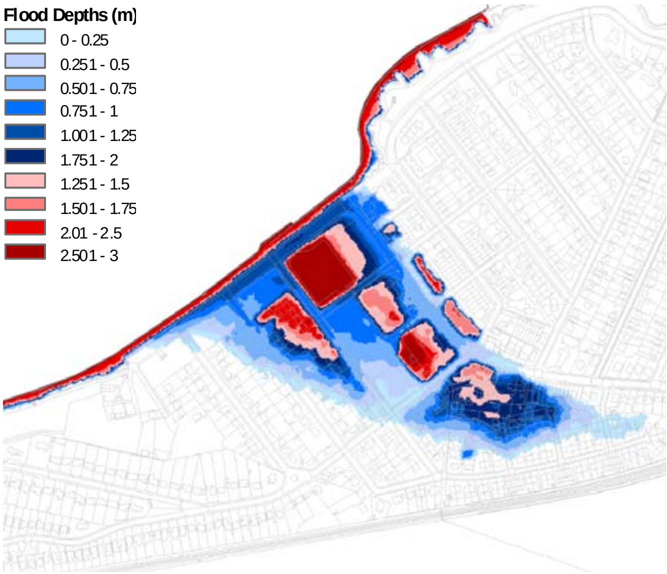

Figure 6 - 1 in 1000 year (2010) Undefended

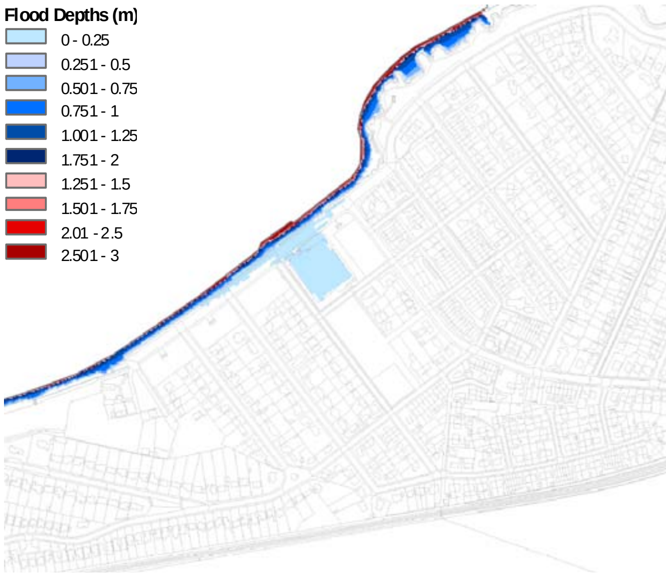

Figure 7 - 1 in 200 year (2115) Undefended

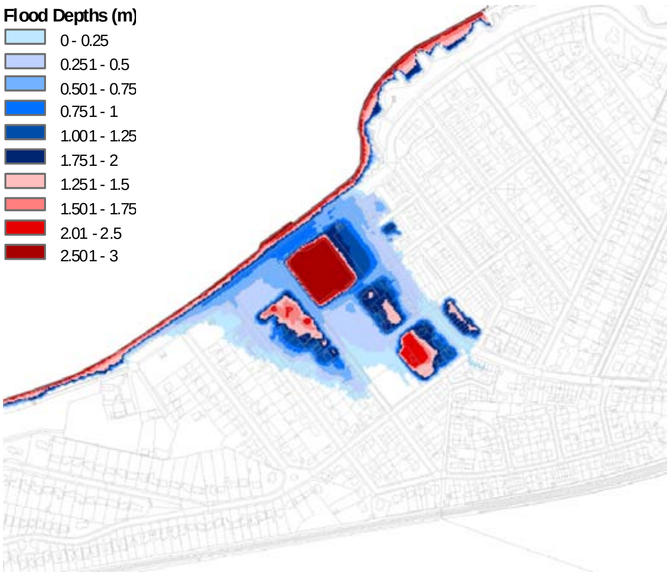

Figure 8 - 1 in 200 year (2010) Undefended

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